

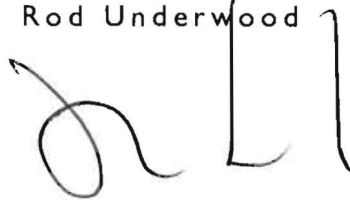
EcoModule: Rethinking Australian Residential Architecture

An Honors Thesis (Arch 402)

by

Michael Edward Downs

Thesis Advisor  
Rod Underwood

A handwritten signature in black ink, appearing to read 'RU', with a long vertical stroke extending upwards from the right side.

Ball State University  
Muncie, Indiana

May 2013

Expected Date of Graduation

May 2013

SPC011  
Undergrad  
Thesis  
LD  
2489  
.Z4  
2013  
.D69

## ABSTRACT

Architectural design is an intricate science and balance between artistic merit, structural resilience, and economy. However, one of the significant elements of architecture is its ability to change through time. During my travels through Australia in the Spring of 2013, I observed the specific architectural environment of Lennox Head, New South Wales. With a vastly different context, location, and environment than the United States, my experience allowed me to understand Australian architectural issues with a subjective lens. With this lens I undertook the task of designing a simple, yet intricate, single-family dwelling that would remedy the current issues of beach construction while simultaneously developing a new perspective on beach cottage architecture. These dwellings could be pre-fabricated, easily assembled and disassembled, and relocated along the coast to existing sites without the compromises of contemporary construction.

## ACKNOWLEDGEMENTS

I would like to thank Rod Underwood for advising me during my studies in Australia and throughout the course of this thesis. His help made it possible for me to carry out my abroad study, as well as this project. Without him, I would have never made it to Australia.

I would also like to thank Lisa Huffman, our abroad advisor, and the staff at Lake Ainsworth and Southern Cross University for their scrupulous hospitality and providing me an experience that I will remember forever.

## AUTHOR'S STATEMENT

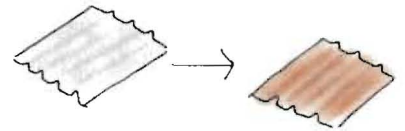
Australia is a country passionate about its life, culture, and environment. The people are passionate about activity, the outdoors, and traveling along their island continent. However, the coastal environment proves difficult for the contemporary methods of construction and devastating natural disasters such as floods, cyclones, and bush fires keep these areas in a constant state of repair. To solve this issue, I began with one of the most common pieces of architecture along the coast: beach houses. These dwellings are the back bone for the adventure-seeking Australians and would serve as a prime precedent for a solution to many of the reoccurring issues. This thesis investigates and proposes a possible solution by designing a economical beach house that is responsive to its social and geographical environments.

# DESIGN CHALLENGE

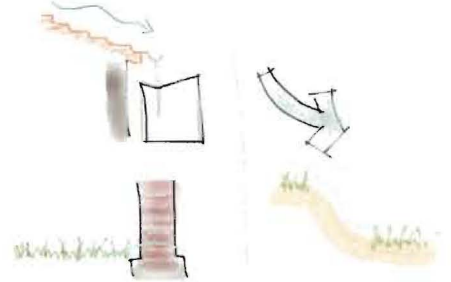
The challenge began with designing an affordable housing option that would accommodate a small family for beach vacations. Moreover, the cottage would need to be economical in its construction and sustainable in its design. To begin this endeavor, I began touring the small beach towns in New South Wales. Here, I observed the major issues occurring along the coast to residential construction and began to take notes on improvements that could be made to remedy these concerns. The primary issues had to do with the methods in which these homes were constructed, the limited amount of space for construction on the site, and long construction delays due to weather and climate. Furthermore, poor construction methods left these cottages in a vulnerable state of repair due to salt erosion, flooding, and structural failure. In order to have a feasible design, the cottage would need to be deliberate in choosing durable materials, creating a structural system that could survive flooding, and be relatively dynamic to accommodate for quick on-site construction, travel, and repairs.

## Coastal Observations

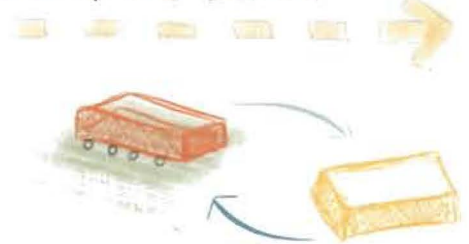
SALT



RAIN

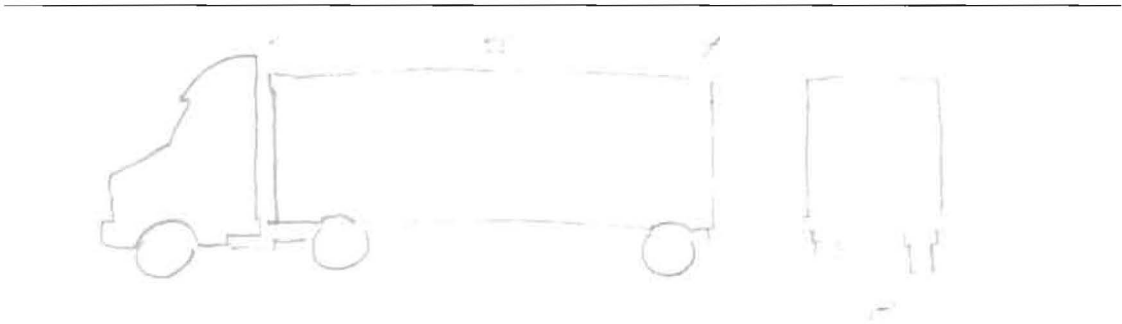


TRAVEL



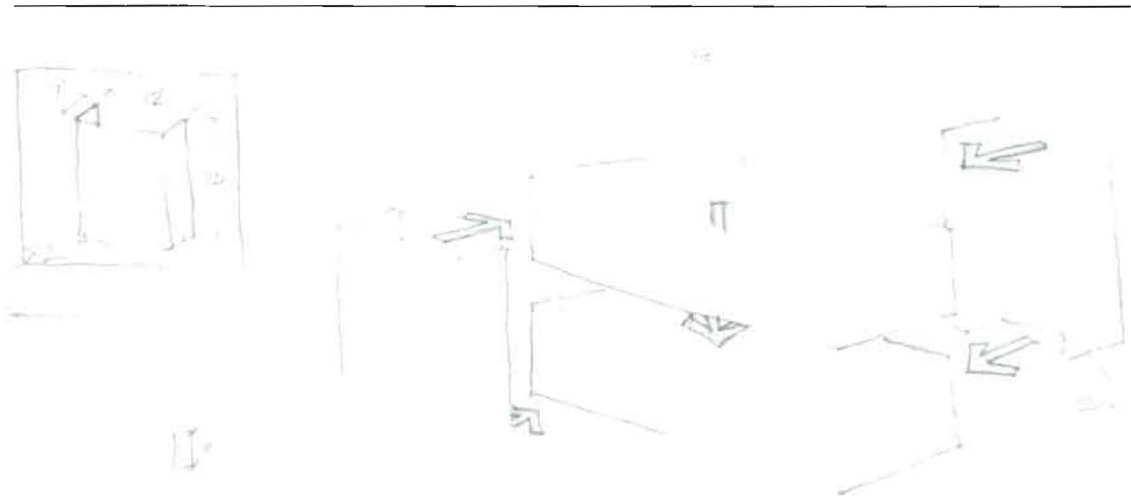
# INITIAL MOVES

To begin designing the cottage, my initial move was to consider how these dwellings were to be constructed. With the limitations of space and unpredictable weather, I sought an option that would develop the home off-site and transport it in pieces to the site for quick assembly. Consequently, the dimensions of these pieces would be limited to the size of a typical semi-trailer carriage, but nevertheless provide an economical solution for transportation. The maximum oversized dimensions of these trailers was found to be 53'x15'x14'



Standard Oversized Dimensions

By developing the cottage off-site and near existing manufacturers, material and transportation costs would be significantly reduced. With these dimensions in mind, I began to develop the cottage program in modules, using the trailer dimensions as a reference. The best organization method to balance this economical solution with the programmatic needs of the family and site would require a two-story lofted cottage. The home itself would consist of two full-trailer modules and two half-trailer modules. Therefore, this design would only require three major transportation costs to the site.



Modules

Assembly



# CONTEXT

The area chosen for the site was to be a 30'x60' standard size beach lot, located near one of the many beach towns along the eastern Australian coast. For reference, I used the neighboring town of Lennox Head and an existing empty lot to demonstrate my design. The lot was located on the south end of the town, with direct access to the beach. This area was chosen for ascetics and would exemplify the worst case scenario for erosion, salt corrosion, flooding, and other natural disaster in the beach town. Lennox Head is a vibrant beach community with many areas for outdoor recreation, exquisite cuisine, and arty vigor. Although the town provides for many of the direct needs of its residents, it remains, like many of the beach towns along the east coast, relatively remote to the larger metropolitan areas in the country. Lennox Head itself is more than one-hundred miles from the closest metropolitan center of Brisbane. This expanse is important in construction methods because as this distance increases, the cost of transportation from major industrial providers, material manufacturers, and professional labor also increases. Due to the proximal location to materials and labor in larger cities, the more production that can happen off site in these centers will greatly reduce the overall cost of the project.



## EXTENDED CONTEXT

To better assess the larger scope of this design proposal, various sites along the east coast were chosen to broaden the prospect and investigate the different contextual environments the design would encounter. Each of these sites had very similar environmental conditions, with only slight variations in coastal composition and exposure to natural disaster. Two of the sites were located in areas with high frequency of bush fires and would experience occasional flooding. Gladstone, on the other hand, was out of the bush fire regions, but, due to its sub-tropical location, experiences heavier rains and more frequent tropical storms such as cyclones.

This investigation shows the lands suitable for the design proposal are existent residential lots that are situated away from site issues such as bluff erosion. Moreover, these lots are reasonably the same and could thus administer the same construction load without compromising their environment.







# STRUCTURAL CONSIDERATIONS

## SALT CORROSION

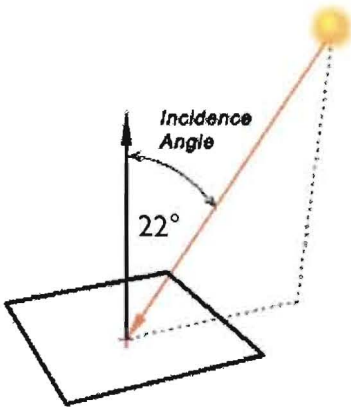
Australia's coastal winds bring in airborne salt and salt water from the sea and can jeopardize the structural integrity of homes. This salt quickens the oxidation process in iron compounds and causes them to rust, weakening their structural strength. The image to the right demonstrates this process. The post, now corroded by the salt in the air, is made of Type 304 stainless steel, while the railing is made of a more corrosive-resistant Type 315 stainless steel. By being deliberate in material selection and choosing materials which have high corrosive-resistant finishes or simply do not rust, such as aluminum, the design can avoid structural failure.



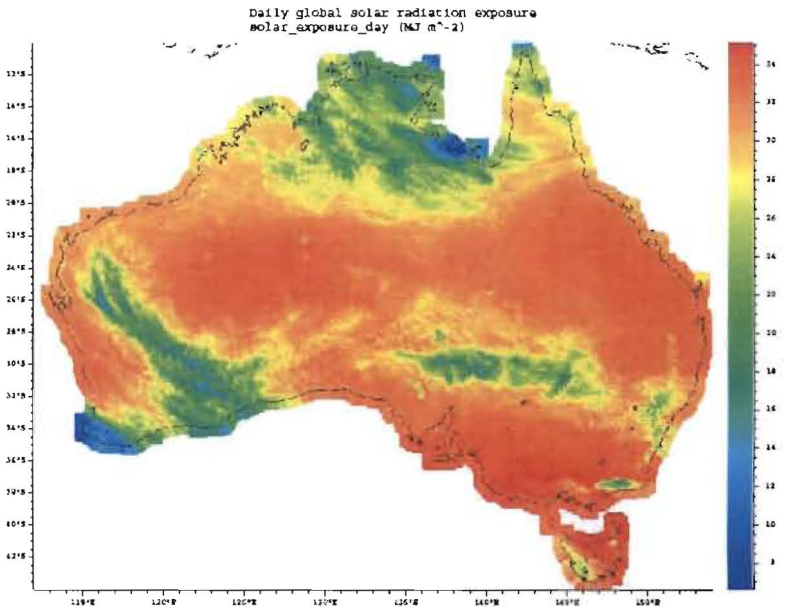
Effects of salt corrosion on different steel materials

## SOLAR EXPOSURE

Australia also has a substantial solar exposure that must be carefully designed for. Too many exposed apertures can cause the home to over heat and cause discomfort. The Australian sun shines from the north, opposite from the southern shining sun we are accustomed to in the United States. Moreover, the tilt of the sun angle, or angle of incidence, is around 22 degrees in Lennox Head. This angle will help in deciding the pitch of solar heating, shading devices, and photovoltaic panels for the roof. The solar exposure graph to the right shows a substantial solar load along the east coast. This exposure is ideal for solar collection, but also suggests limiting the window apertures on the northern facade (Weymouth).

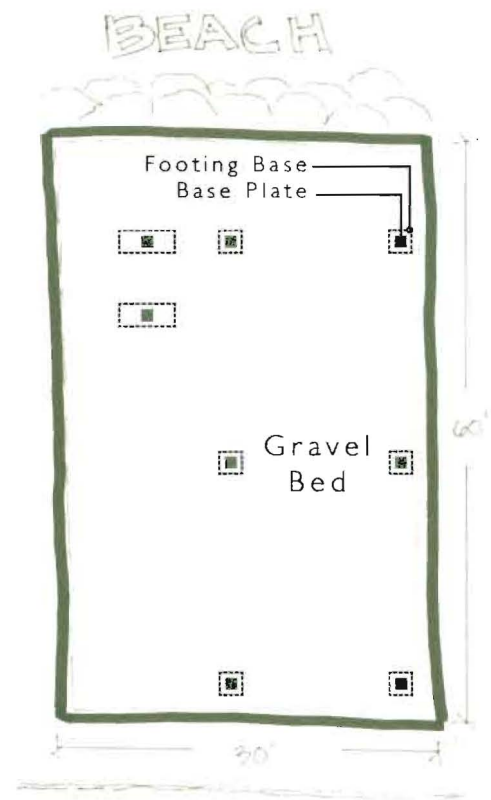


Angle of Incidence, Lennox Head Australia



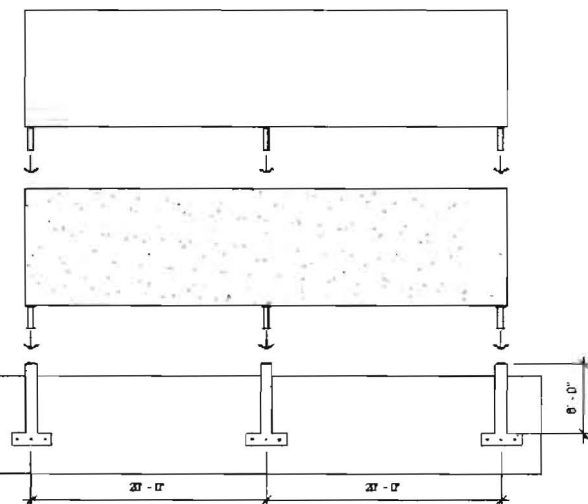
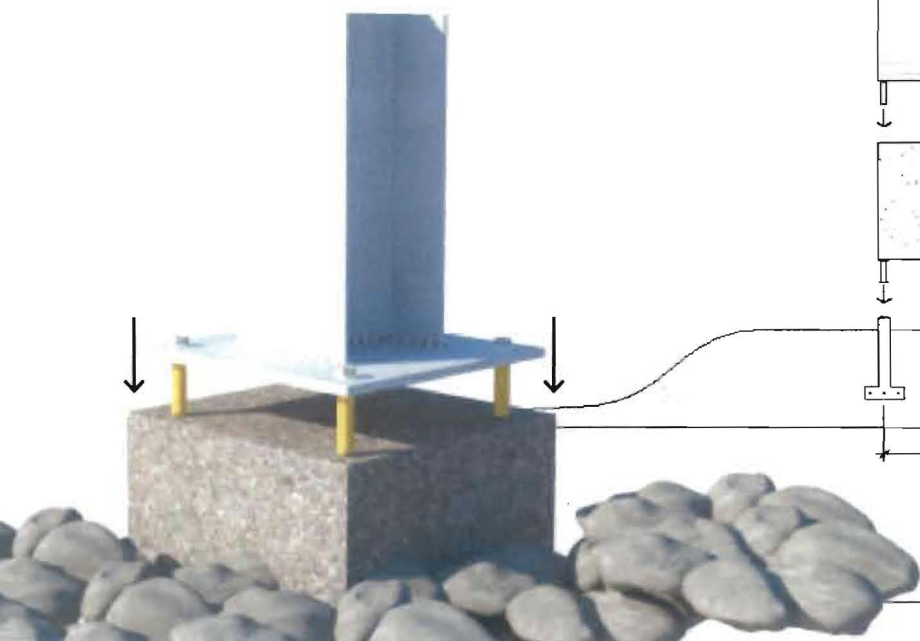
# SITE CONSIDERATIONS

In order to have a workable design, the site also needed to be accommodated for quick assembly. Moreover, the issues with flooding and ground saturation called for a slightly elevated structure that would protect the assembled cottage from water damage and erosion. The only site work that would be necessary for the design would be a structural foundation consisting of 8 reinforced concrete footings, with protected steel base plates to connect the cottage modules to the foundation. The site would be an arbitrary coastal lot with standard beach lot dimensions. This would allow multiple sites along the coast to be prepped for the assembly, allowing the same cottage construction to be moved from one coastal site to another, without the need of added site work, demolition, or ground breaking.



Foundation Plan

## Foundation Detail



Foundation Section



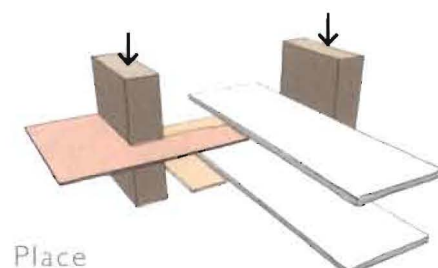
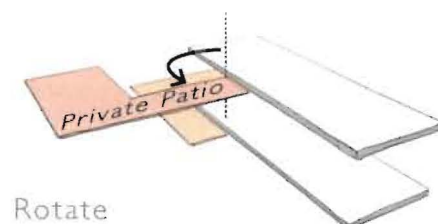
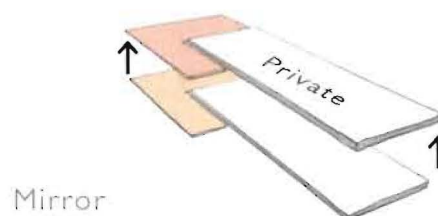
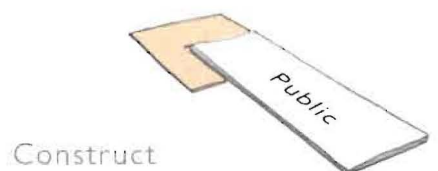
# PROGRAMMATIC DESIGN

The program for the design was broken up into four modules. The first two of these modules would each be a full size, 50'x15'x10' piece that would stack one on top of the other. The lower level would service the public program, including the kitchen, the living room, patio, and the laundry room. The upper level would provide for the private needs of the family: bathroom, bedroom, and private balcony. The east end of the upper level would be open to the living room below.

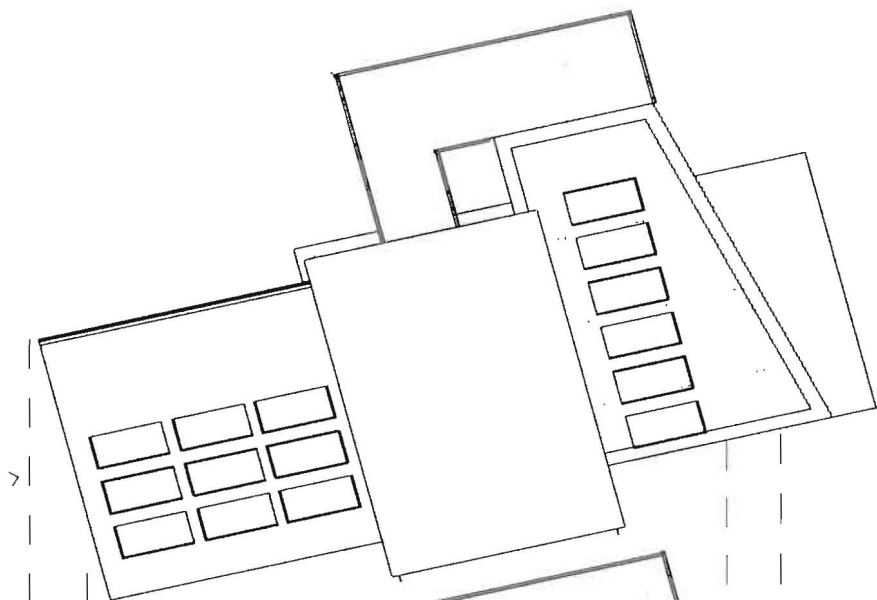
The other two modules would be half-sized pieces; measuring only 15'x7'x20'. This would allow both pieces to be transported on one semi-trailer and reduce transportation cost. The first of these modules would serve as the vertical circulation to the upper level. To make use of every square-foot of the space, the area underneath the stairs would be used as a semi-private reading nook. Furthermore, the stair tower would also contain operable windows to facilitate cross-ventilation. The last module would contain the sustainable features of the cottage; housing the rain collection cistern, pumps, and usable grey-water filtration systems. Moreover, this two-story module would also contain the inverters, batteries, and storage for the photovoltaic panels on the roof.



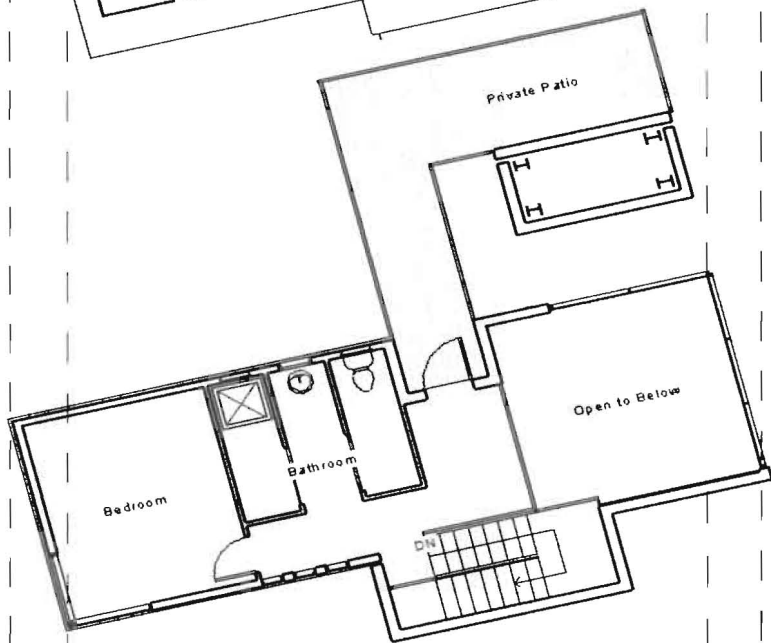
## Schematic Design Process



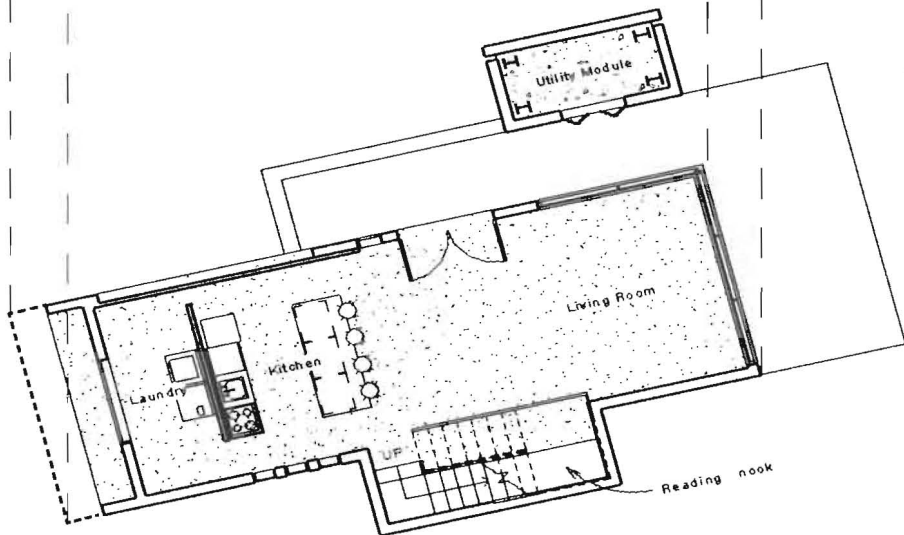
FLOOR PLANS



ROOF PLAN



SECOND FLOOR

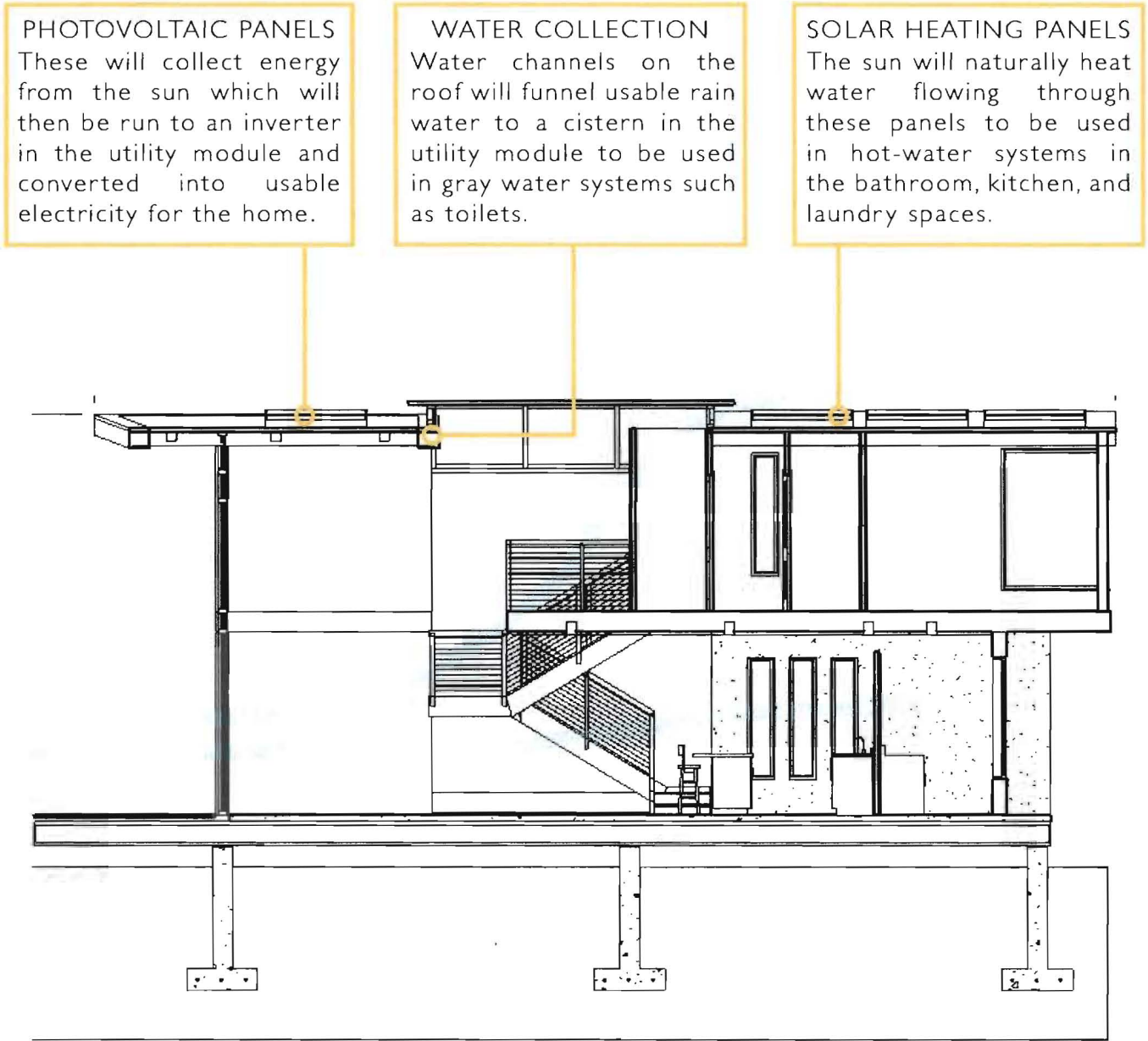


FIRST FLOOR

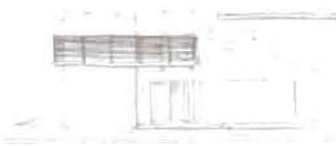




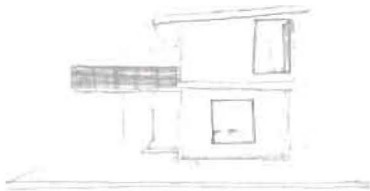
# SUSTAINABLE SYSTEMS



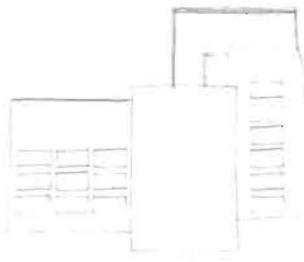
ELEVATIONS



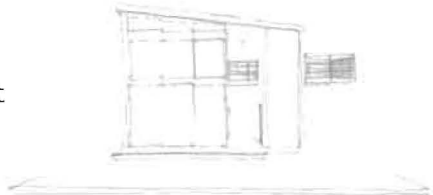
North



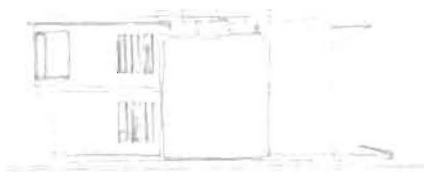
West



South



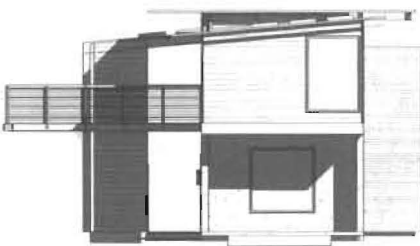
East



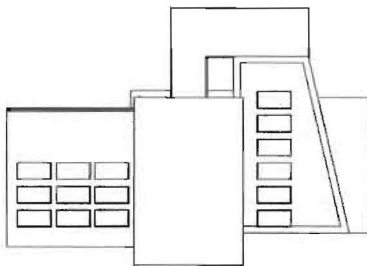
PRELIMINARY SKETCHES



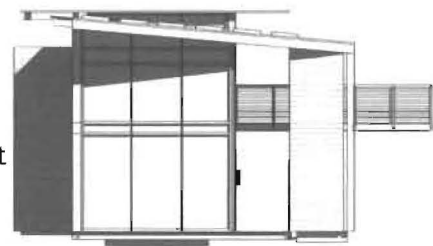
North



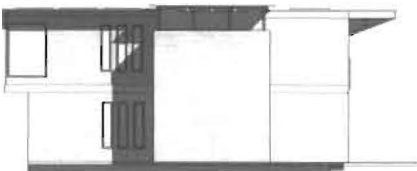
West



South



East



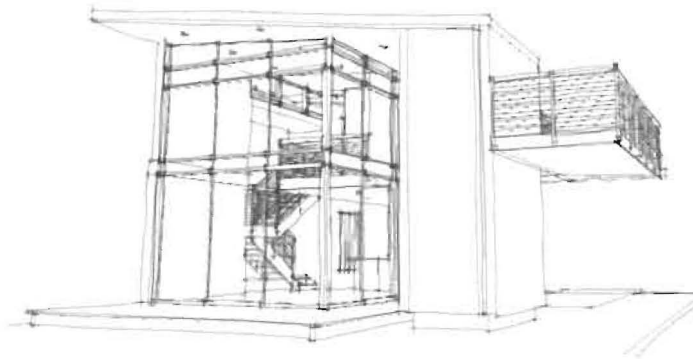
FINAL CONSTRUCTS

# MATERIAL SELECTION

The design of the cottage would also be deliberate in its material selection to maximize its economical and sustainable value. The lower public space would be a precast concrete module, capable of supporting the upper level. Additional exterior finishes such as a stone veneer can be added for a desired aesthetic. The upper module would be a lighter-weight aluminum framed space with exterior wood rain screening. This would allow the module to be more easily lifted above the lower modules on site. The roofing would be corrugated aluminum sheets pitched north at a 5% slope to maximize sun exposure on the 15 solar panels, typical in most Australian construction. The ceiling finishes of the interior and exterior would be made of recycled skid wood and ply wood sheets. The footings at the base would be sheltered by an aluminum casing to give the base a solid aesthetic and protect the footing connections from any wind-drawn salt water.



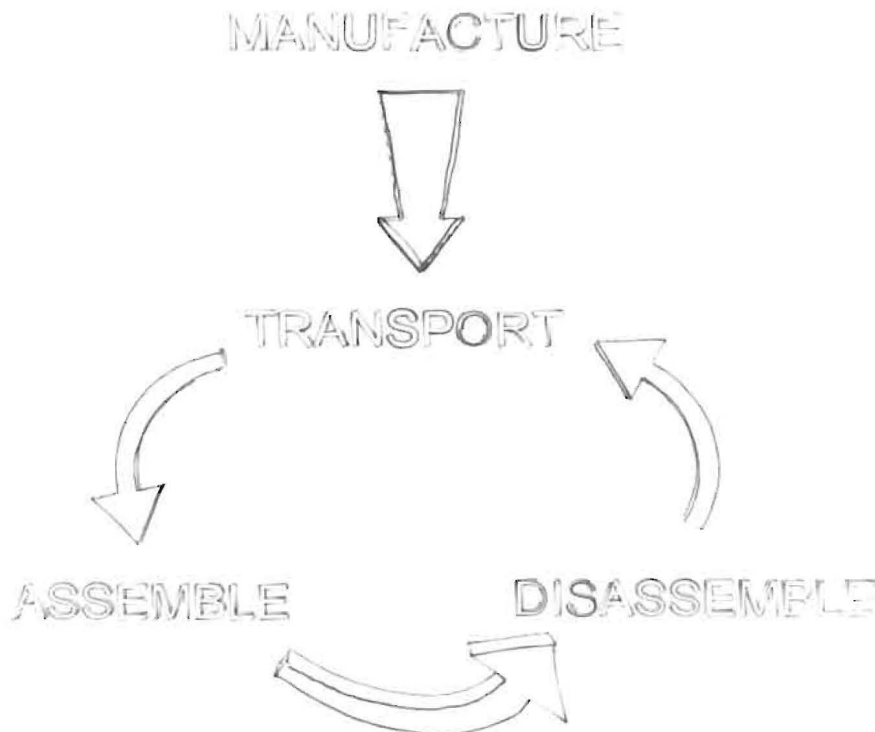
Front Street Entry



Back Beach Entry

# FUTURE PROSPECTS

The goal of this project was to investigate the potential and possibility of mobile, economical, and sustainable architecture. The notion behind these cottages would be that they would save both the fragile environment from constant coastal construction and the economy by building a single dwelling that could essentially fit and be assembled in a multitude of locations along the coast. This proposal offers only a single dwelling design that could be prefabricated to fit on a planned site. My vision is to create a series of these identical bed-sites that could essentially support several different module cottage designs and introduce an interesting dynamic to this process. For example, a family could move their home from New South Wales to Queensland without the stress of looking for, or even constructing, new residential properties. In another way, these homes could also save hundreds of residents from the devastation of natural disaster. Homes that are in the line of a cyclone or approaching bush fire could be relocated to protect entire residential blocks from otherwise sure destruction. Moreover, the advancement of this idea could develop cottages that may look completely different from one another, but still adhere to the site foundation conditions. Australia is a country passionate for travel and adventure. However, its environmental conditions can prove hazardous to many architectural languages. By developing a dynamic, economic, and environmentally-sensitive proposal, I believe this cottage design could be a feasible solution to Australian coastal architecture.



## WORKS CITED

- Australian Emergency Management. Australian Government: Attorney General's Department, n.d. Web. 28 February 2013. This site was used for climatic and environmental data along the East coast of Australia. Maps were used to assess the risks of flooding, bush fire, and other natural disaster in the design locations.
- "CSIRO." Bushfire in Australia. Commonwealth Scientific and Industrial Research Organisation, 14 Feb. 2008. Web. 23 Feb. 2013. This resource was used to explain the effects and dangers of Australian bush fires.
- Duncan, D.B. "St. Mary Star of the Sea." Northern Territory Organs. Organ Historical Trust of Australia, n.d. Web. 28 Mar. 2013. Natural Disaster Images.
- "Incidence of Poxvirus-like Lesions in Two Estuarine Dolphin Populations in Australia: Links to Flood Events." ScienceDirect.com. Marine Ecology Research Centre, School of Environmental Science and Management, Southern Cross University, n.d. Web. 28 Mar. 2013.
- International Molybdenum Association, and Catherine Houska. "Case Study 09: Australian Coastal Fence." IMO (2009): n. pag. Web. This resource was used in discovering and explaining the corrosive effects of salt on steel through a applicable case study conducted in Australia.
- "Stainless Steel Selection in Coastal Environments." Stainless Steel in Architecture: Coastal Salt. International Molybdenum Association, 2009. Web. 28 Mar. 2013. This resource was used to explain the corrosive effects of salt on construction materials.
- Weymouth, G., Le Marshall, J. F., 2001, Estimation of daily surface solar exposure using GMS-5 stretched-VISSR observations: The system and basic results, Australian Meteorological Magazine, 50, 263-278. Climate map images.